
# Ecosystem Objectives

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# Section 3: Ecosystem Objectives

## 3.1 Introduction

The Lake Erie LaMP has adopted a generalized ecosystem approach, as outlined in the 1987 amendments to the Great Lakes Water Quality Agreement (GLWQA). This approach recognizes that all components of the ecosystem are interdependent, including the water, biota, surrounding watershed and atmosphere. Humans are considered an integral part of the system.

The need to recognize this interdependence is underlined by observations from the recent ecological history of Lake Erie. The eutrophic conditions of the 1950s to1970s were caused by high phosphorus loading (Burns, 1976; Chapra, 1977) and remediated by phosphorus reduction programs designed to meet target concentrations. During the 1960s and 1970s, the fish community of Lake Erie was extremely degraded (Hartman, 1972). Under conditions of reduced phosphorus loading and international cooperation in fisheries management, there was a recovery in the walleye fishery (Hatch *et al.,*1987; Knight, 1997). Subsequently, Makarewicz and Bertram (1991) showed that the structure of the food web was reflecting the influence of both bottom-up (nutrient reduction) and top-down (predation) structuring (McQueen *et al.,* 1986; Munawar *et al.,* 1999).

The Great Lakes Water Quality Agreement calls for the development of ecosystem objectives and indicators for all of the Great Lakes. For Lake Erie, the level of change in the ecosystem has been extensive, and in many cases appears irreversible (Burns 1985). We cannot return to the pre-settlement conditions of the pre-1700s, but we can work toward achieving a healthier, more diverse and less contaminated ecosystem. Therefore, the Lake Erie LaMP will first identify *ecosystem alternatives* for Lake Erie before developing ecosystem objectives. *Ecosystem alternatives are* ***qualitative*** *descriptive statements of desired future conditions* for the Lake Erie basin, including nearshore and offshore waters, tributaries, flora and fauna. Ecosystem alternatives must reflect society's environmental, social and economic values and are therefore being developed with input from the public.

The approach for Lake Erie is to examine the effects on the state of the system that may be achieved through management actions, or levers, that address: 1) reduction of contaminants loading; 2) phosphorus management; 3) changes in land use; 4) control of exploitation by sport and commercial fisheries, hunting and trapping; and 5) creation and restoration of natural landscapes. These are the five major *management levers* with which we can alter the condition of the ecosystem.

Once the preferred ecosystem alternative is selected, ecosystem objectives must be developed taking into account the competitive uses within the Lake Erie ecosystem, such as industry, urban growth, agricultural or recreational uses. Finally, indicators must be developed. Ecosystem indicators have been identified (SOLEC, 1998) as measurable features that provide managerially and scientifically useful evidence of environmental and ecosystem quality, or reliable evidence of trends in quality. It is desirable to link closely to the SOLEC indicator exercise where possible. However, the definition of indicators must be broadened for the Lake Erie LaMP ecosystem objectives effort to: *Indicators are measurable features which identify the current state of the ecosystem relative to the desired state of the ecosystem.*

### 3.2 Ecosystem Alternative Development Process

The Lake Erie LaMP Ecosystem Objectives Subcommittee (EOSC) was charged with the task of developing ecosystem objectives for Lake Erie. The EOSC is a binational group of about 15 individuals with expertise in limnology, water quality, and fisheries and wildlife management. Three members of the Lake Erie Binational Public Forum have worked closely with the committee throughout the exercise. Again, the first step in the process was to identify ecosystem alternatives. The committee began the exercise by holding four public workshops around the basin to gain ideas on the desired state of the Lake Erie ecosystem. This was followed by an expert workshop where published information and expert opinion was solicited concerning key relationships in the ecosystem.

A conceptual model of three ecosystem alternatives was developed for initial discussion. Several other attempts at developing a model that could be used for Lake Erie were made. As a result, a fuzzy cognitive map (FCM) approach was adopted to model ecosystem alternatives for Lake Erie. A FCM model is one way to analyze a complex system by representing the most important components of that system as nodes of a network. Individual nodes are connected to many other nodes. A change at one node will affect all connected nodes, and then all the nodes connected to those nodes, generating a ripple effect. Taking an FCM approach required more data and, therefore, a second expert workshop was held. The results of the second workshop led to the development of an FCM model for the lake dubbed the Lake Erie Systems Model. The model will be used as a tool to help understand how various components of the ecosystem interact, but it is not a panacea to predict future conditions.

Three major categories of actions and reactions are used to explain the output of the Lake Erie Systems Model: 1) management levers; 2) ecosystem health response; and 3) beneficial use to humans. Management levers are a variety of human actions that affect the ecosystem. Ecosystem health response describes the condition of individual biotic and habitat components and the reaction to the management levers. Beneficial use refers to those human uses defined in the GLWQA that are affected by the management levers. By randomly and simultaneously moving all management levers in different directions and monitoring responses of all non-lever variables, a large set of different potential outcomes in the ecosystem can be generated. These outcomes can then be grouped into a form that can be recognized and described using a statistical clustering procedure. Groups that are considered to be significantly different from each other constitute *ecosystem alternatives*. A detailed description of how the model was developed and how it processes data can be found in the ecosystem objectives subcommittee's report, Colavecchia *et al.* (in prep.).



The model generated various ecosystem alternatives. These alternatives do not include social, economic or political values because they are not part of the ecosystem. Rather, the values are what will be used to determine the ecosystem alternative that we choose. These issues will be incorporated into the decision-making process described in section 3.4, and also as we proceed with identifying specific ecosystem objectives.

### 3.3 Draft Ecosystem Alternatives

Protection of natural, undeveloped land in the Lake Erie basin is the most effective way to return Lake Erie to a more pristine state. Of the management levers examined in the model, those that affect the availability of natural, undisturbed land cause the largest response across the greatest number of variables. Therefore, the availability of natural lands is the key driver of the ecosystem clusters. Nutrient levels are the second most important influence but do not have the impact that natural land (habitat) has on the ecosystem. In other words, phosphorus can be strictly managed, but unless natural land or habitat is protected and restored, only marginal response will be seen by many components of the ecosystem. Therefore, the ecosystem alternatives derived from the model will be described based on their gain in natural land compared to the status quo conditions of the 1990s. Therefore, of the management levers, land use practices and phosphorus (or nutrient) management will have the most impact on improving Lake Erie.

From the clustering exercise, seven distinct groups (ecosystem alternatives) emerged. Three groups represented highly degraded environmental conditions relative to present (1990), while four represented existing or improved environmental conditions. Only the latter four groups are considered viable ecosystem alternatives for a future state of Lake Erie. Ecosystem alternative #4 (ECA#4) represents the status quo, or existing conditions. ECA#1 represents a moderate gain in natural lands from the status quo. ECA#2 represents a high gain in natural lands, and ECA#3 represents low gain of natural land.

A more detailed description of the impact on ecosystem health and human uses associated with each ECA based on the management actions implemented is presented in Table 3.1. These alternative states, or ecosystem alternatives, are pictures of what the Lake Erie environment could be depending on how and to what extent the human population is willing to adjust future land use needs. Many combinations of management actions are possible to achieve each ecosystem alternative. Each of the ecosystem alternatives presented serve to only broadly group the management actions that could be implemented to obtain them. The ecosystem objectives that will subsequently be developed under the preferred ecosystem alternative will contain more specific language to guide management actions.

The Lake Erie Systems Model assumes that toxic contaminants will be managed according to the GLWQA principles of zero discharge and virtual elimination. There is already a strong focus on rehabilitating those areas of Lake Erie that are adversely affected by persistent toxic chemicals, such as the AOCs. As such, levels of contaminants should be declining, not present at varying levels, and not controlling other ecosystem components. Ecosystem objectives for Lake Erie will not be proposed that allow toxic substances to exist in toxic amounts to the detriment of human health or wildlife. Therefore, all four ECAs begin with the assumption that loading of contaminants into the Lake Erie ecosystem has been reduced to zero, and describe a contaminant free ecosystem. However, a representation of the processes of contaminants has been incorporated into the model to ensure that the implications can be considered in forecasts for the future. If zero discharge is not achieved, contaminant levels in the ecosystem (hence, negative impacts on the ecosystem) would be expected to be the highest under ECA#4 (status quo), reduced under ECA#2 and ECA#3, and lowest under ECA#1.

Table 3.1 illustrates the results of the model for each ECA. For management levers, the more symbols, the less environmental stress is occurring. For the response to ecosystem health and human uses, a *Consumer's Report* format is used to show differences in responses. A full circle has the highest potential for improving ecosystem health or human use; an open circle the least.

### Table 3.1 Response of Various Lake Erie Ecosystem Components Under the Four Ecosystem Alternative (ECA) States as Derived from the Lake Erie Systems Model

| CATEGORY | Ecosystem COMPONENT | ECA#1 | ECA#2 | ECA#3 | ECA#4 |
|---|---|---|---|---|---|
| **Management Levers** | Phosphorus loading | 🧍🧍🧍🧍 | 🧍🧍🧍 | 🧍🧍🧍 | 🧍🧍 |
| | Changes in land use | 🧍🧍🧍 | 🧍🧍🧍🧍 | 🧍🧍 | 🧍🧍 |
| | Harvest - fishing, hunting, trapping | 🧍🧍 | 🧍🧍 | 🧍🧍 | 🧍🧍 |
| | Restoration of natural landscapes | 🧍🧍 | 🧍🧍🧍 | 🧍🧍 | 🧍🧍 |
| **Ecosystem Health** | Environment/Habitat | ● | ● | ◔ | ◔ |
| | Plankton | ○ | ○ | ○ | ◔ |
| | Aquatic Plants | ● | ● | ◑ | ◔ |
| | Benthos (Cold-Water) | ○ | ○ | ○ | ○ |
| | Benthos (Cool-Water) [a] | ◔ | ◔ | ◔ | ◑ |
| | Amphibians | ● | ● | ◔ | ◑ |
| | Reptiles | ◑ | ● | ◔ | ◔ |
| | Fish | ◑ | ● | ◔ | ◔ |
| | Birds | ◑ | ● | ○ | ◔ |
| | Mammals | ● | ● | ◔ | ◑ |
| **Beneficial Use to Humans** | Natural environments | ● | ● | ◔ | ◑ |
| | Less *Cladophora* on beach | ◑ | ◑ | ◑ | ◔ |
| | Water transparency nearshore | ● | ◑ | ◑ | ◔ |
| | Swimmability (Bacteria) | ● | ◑ | ◑ | ◔ |
| | Absence of consumption advisories | ● | ◑ | ◑ | ◔ |
| | Absence of need to dredge | ● | ● | ◑ | ◔ |
| | Drinking water/taste and odor | ● | ◑ | ◑ | ◔ |

[a] Benthos is showing degradation compared to the status quo due to the suppression of organisms like *Diporeia* and *Mysis* by Dreissenid mussels.

## 3.4 Decision-making process for selecting an ecosystem alternative

As noted at the end of section 3.1, there are three steps involved in setting a direction for the Lake Erie ecosystem: 1) a preferred ecosystem alternative must be selected; 2) ecosystem objectives must be developed that describe in narrative form more details to set the stage for the actions needed to achieve the preferred alternative; and 3) indicators must be developed to measure progress in achieving the desired ecosystem alternative. The process described below addresses primarily the selection of an ecosystem alternative.

***Who* will evaluate the ecosystem alternatives?**

- Members of the LaMP Work Group, who have already eliminated three of seven ecosystem alternatives from consideration. The work group will consider the opinions of the interested public along with agency personnel, and will make recommendations to be considered by the LaMP Management Committee.
- Members of the Lake Erie Binational Public Forum, who will consider the four remaining alternatives at two of their meetings, and whose opinions and recommendations will be considered by the Work Group and Management Committee.
- Interested members of the public at large who choose to attend open meetings at which the ecosystem alternatives will be presented and discussed.

- Agency personnel who will provide comments to their Work Group member.
- The LaMP Management Committee, who will make the final approval.

The input that is expected includes:
- Comments, concerns, and suggestions provided by the public representatives and agency staff concerning the relative advantages and disadvantages of particular ECAs. Some of this information will elaborate upon or complement the presented descriptions of the ecological, beneficial use, social, and economic implications of the ECAs. However**,** participants in the consultation process may **also** provide information or their interpretation of the effects of the ECA that contribute to a more complete understanding of the implications.
- Polling-type data on the preferences of representatives of the public for the different ECAs. This information will not only indicate the extent to which agreement on the objectives is possible or exists, but also the reasons for differing views on the ECAs. Differences of opinion could arise due to differing understandings of the environmental and social implications of the ECAs; they can also occur because of fundamental differences in values among participants. Documentation of these reasons is critical. For the Public Forum, effective communication of this information is crucial to its stated role of "promoting the Forum's vision and goals for Lake Erie".

***What* information will be used by the process and what product is anticipated?**
Information provided to evaluators will include the four ecosystem alternatives described in section 3.3. Each ECA describes, in very general terms, both a direction for the Lake to go (what types of changes to make, if any) and how far to go.
The final product of the process is to be:
- A preferred future state for the Lake Erie ecosystem, which will correspond to one of the ECAs, or perhaps a combination, and;
- The preferred state will be described in terms of the general policy levers that are likely to be necessary to achieve it, and a qualitative summary of the resulting ecosystem health, effects on beneficial uses, and social and economic costs and benefits (broadly construed).

Detailed, quantitative information on the impacts and characteristics of the chosen alternative will not be included. This is because the policies and management measures required to achieve them cannot be specified exactly, and tools for projecting ecological, economic, and social effects are unavailable within the time frame required.

Consequently, the selected alternative should *not* be viewed as a firm and unswerving commitment to a precise target for the future state of the system. As more information becomes available about what actions are required and their likely effects, it is anticipated that adjustments may be made. Rather, the alternatives represent a set of guiding principles; they are a policy commitment that management actions should be constructed and evaluated considering the Lake Erie LaMP's commitment to moving the Lake in the direction implied by the alternatives.

***When and where* will consultation on the ecosystem alternatives take place?**
The following sequence of events will occur:

*May 2000: Submission of draft materials on ECAs for evaluation at the June 2000 Binational Public Forum meeting.*

*June 2000 Binational Public Forum meeting: Initial assessment of ecosystem alternatives.*

*July 31, 2000: Materials on ecosystem alternatives to be finalized and subsequently distributed to the Forum and interested public.*

*September-October 2000: Public meetings (approximately four in each country).*

*September-November 2000: Forum members consult as individuals with their constituencies and other members of the public.* Forum members will have two tasks: to communicate information about the ecosystem objectives' process and ECAs, and to gather information on how their groups and other members of the public view the alternatives.

*November 2000 Public Forum meeting: Final assessment of ECAs.* Final polling of the Forum's views of the ECAs. The Forum would also discuss the phrasing of the ecosystem objectives that would be implied by the Forum member recommendation of a preferred ecosystem alternative.

*December 2000: Work Group and Management Committee recommendations.* The Work Group will make recommendations concerning the ecosystem alternatives, and the Management Committee will be responsible for the final approval.

*January-April 2001*: Ecosystem objectives are developed based on the preferred ecosystem alternative.

## 3.5 References

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